EVALUATION OF INDEPENDENT ASSURANCE SAMPLING AND TESTING VARIATION LIMITS

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16. Abstract

The principal objective of this project is to examine the existing IAST data and to suggest variation limits for the currently listed IAST tests. These suggested variation limits might serve as criteria to determine the accuracy and validity of the acceptance sampling testing and process control protocols and help compare individual testing results. In developing these new IAST limits, past data (since 1991) were entered into a computer and analyzed by statistical software. This report summarizes the analysis carried out by URI on RIDOT data of various test results from 1991 to 1999. Test data were analyzed for the following materials: hot mix asphalt, portland cement concrete, and soils. Also, a paired t-test was conducted to investigate if a significant difference exists between the IAST and the acceptance tests. Statistical approaches were employed to develop new variation limits for each of the tests conducted on the three materials. Comparisons were made between existing IAST limits and the limits developed by URI. For each test, various IAST variation limits were compared with the limits developed in this study. Comparisons were made on data regarding the gradation and asphalt content of hot mix asphalt, the slump and air content and the aggregate gradation of Portland cement concrete, and in place density and moisture content of soils. A standard procedure was suggested to determine IAST limits for a new test.

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1. SUMMARY

The principal objective of this project is to examine the existing IAST data and to suggest variation limits for the currently listed IAST tests. These suggested variation limits might serve as criteria to determine the accuracy and validity of the acceptance sampling testing and process control protocols and help compare individual testing results. In developing these new IAST limits, past data (since 1991) were entered into a computer and analyzed by statistical software.

This report summarizes the analysis carried out by URI on RIDOT data of various test results from 1991 to 1999. Test data were analyzed for the following materials: hot mix asphalt, portland cement concrete, and soils. Also, a paired t-test was conducted to investigate if a significant difference exists between the IAST and the acceptance tests. Statistical approaches were employed to develop new variation limits for each of the tests conducted on the three materials. Comparisons were made between existing IAST limits and the limits developed by URI.

For each test, various IAST variation limits were compared with the limits developed in this study. Comparisons were made on data regarding the gradation and asphalt content of hot mix asphalt, the slump and air content and the aggregate gradation of Portland cement concrete, and in place density and moisture content of soils. The classification of these various tests conducted for the three materials is shown below in Figure 1.

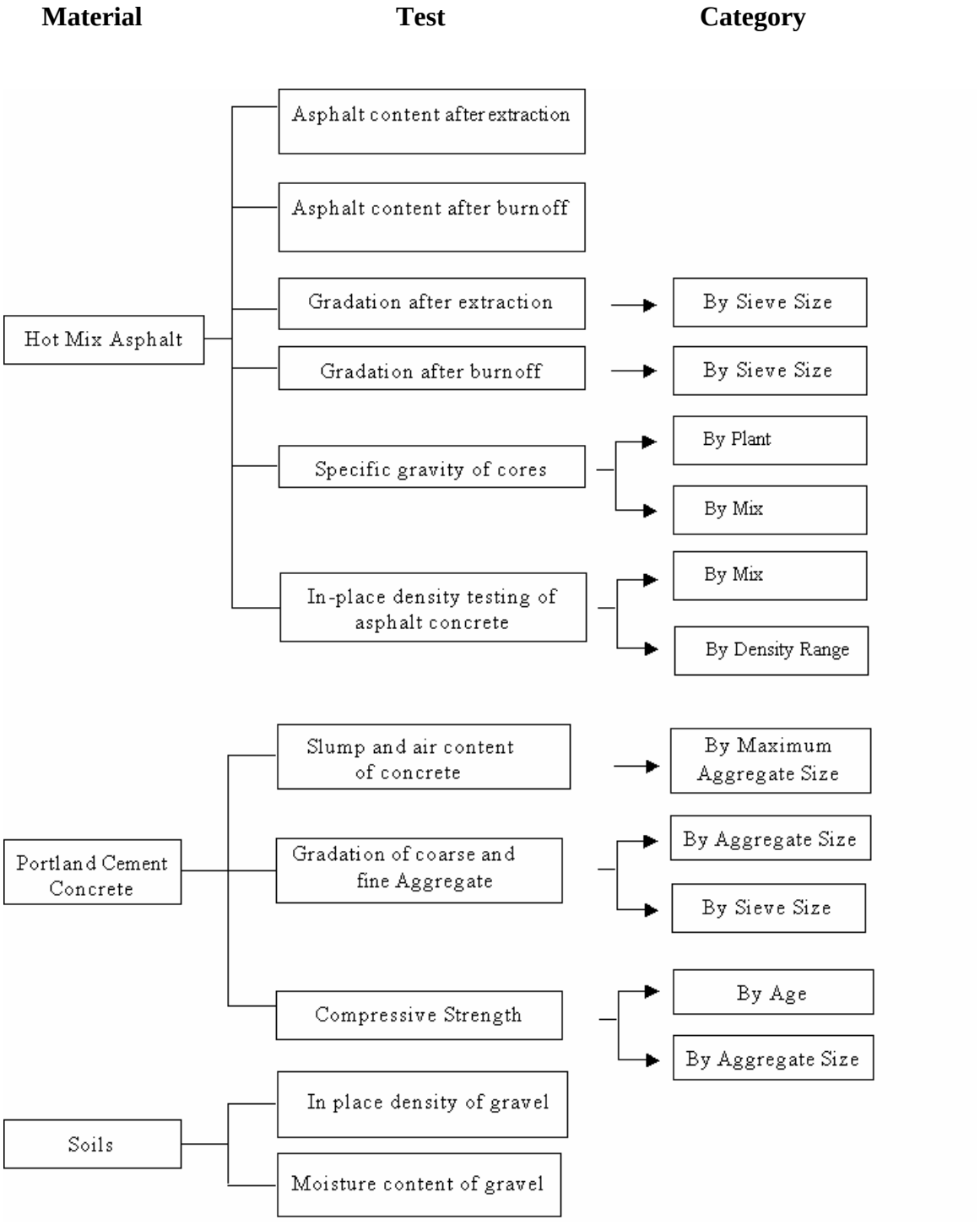

Figure 1 – Test Classification for Hot Mix Asphalt, Portland Cement Concrete and Soils

2. APPROACH

2.1 Data Entry

The RIDOT data was entered into a database using an MS Access platform. To make data entry comfortable and user-friendly, interactive menu-driven forms have been created. For example, a data entry form created for gradation of coarse aggregate for Portland cement concrete by blend is shown in Figure 2. As shown, Drop-down menus are provided for entering the plant, sieve-size, mix-type, and the technician.

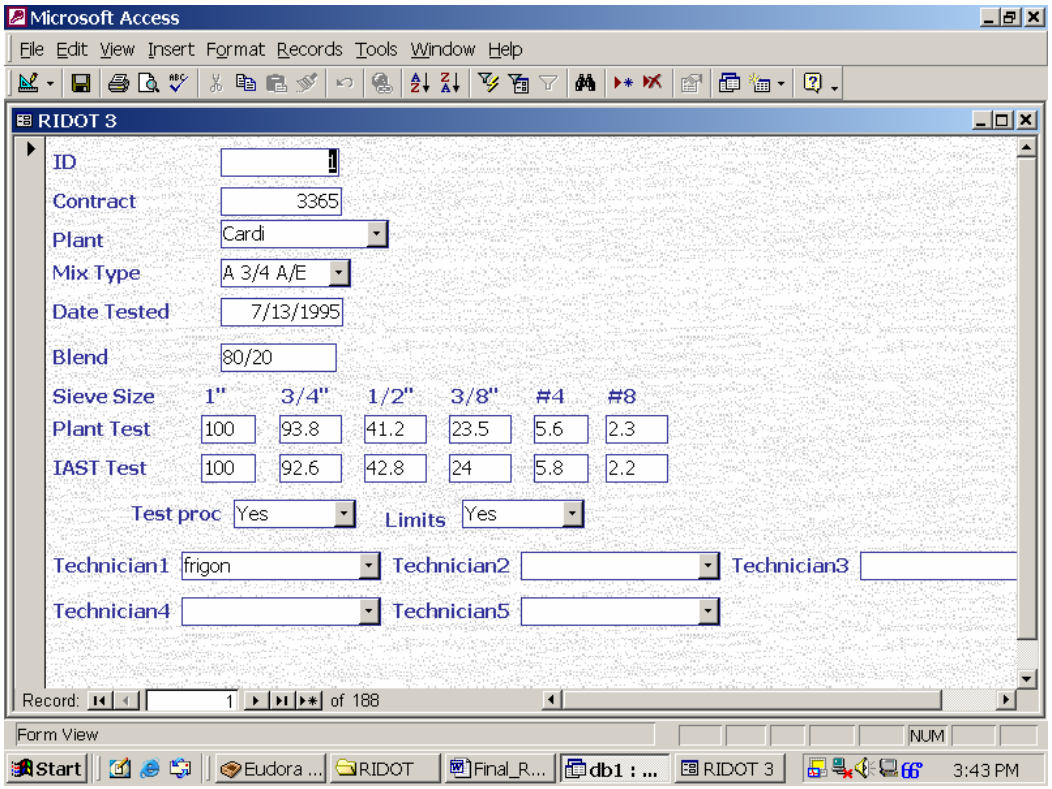

Figure 2 – Data Entry Form for gradation of coarse aggregate for Portland cement concrete by blend

The data entered in the forms can be accessed from the database by queries. Queries were created to retrieve data according to specific criteria such as, plant, mix-type, aggregate size, sieve size, etc. The query design for retrieving data for gradation of coarse aggregate for Portland cement concrete by blend is shown in Figure 3.

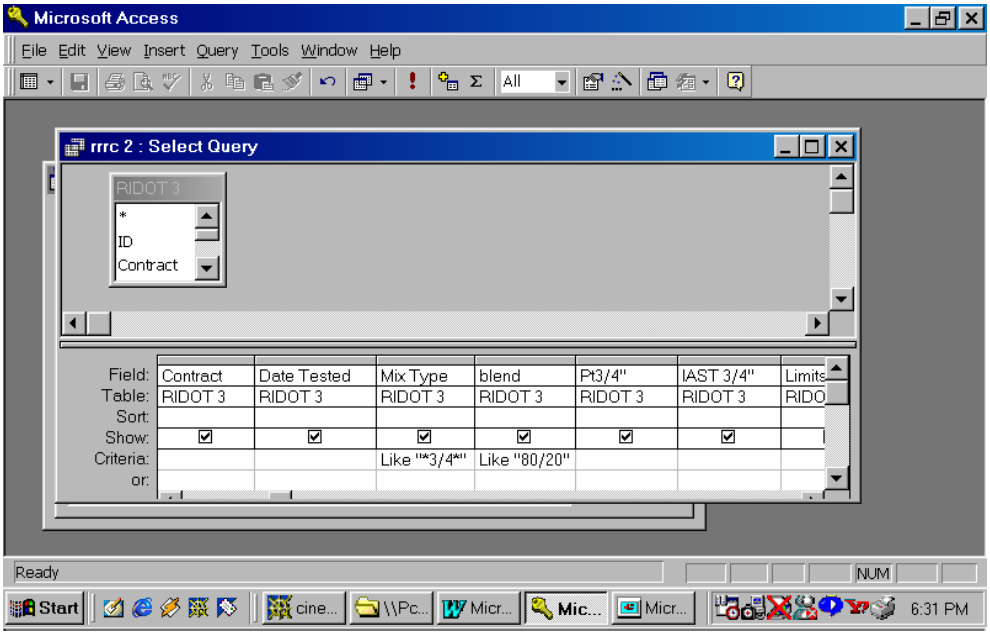

Figure 3 – Query selection for gradation of coarse aggregate for portland cement concrete by mix type and by blend

Figure 4 shows part of the data generated from the above which retrieved data records with mix type = “3/4” and blend = “80/20”.

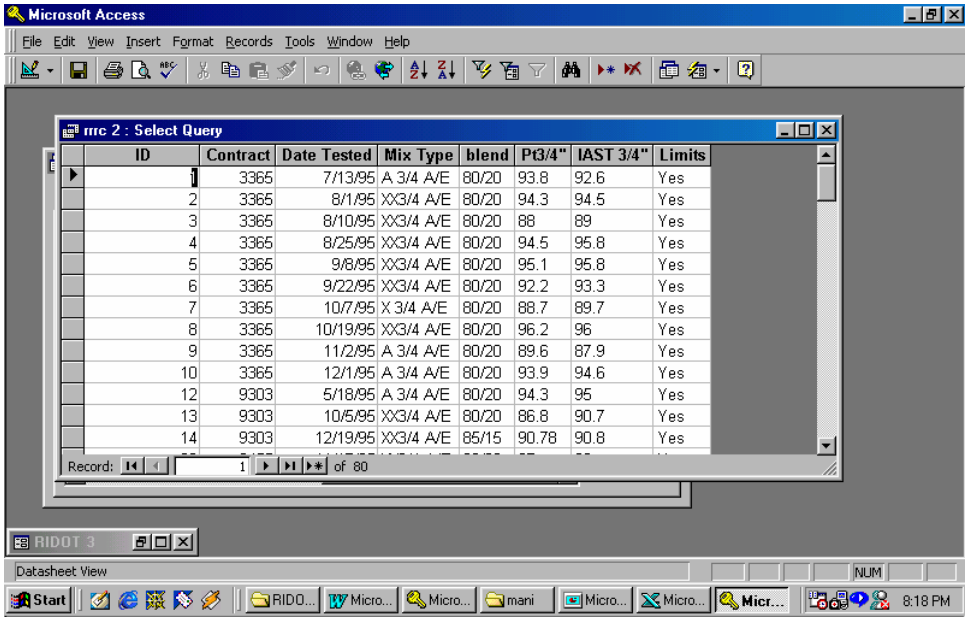

Figure 4 - Query result for gradation of coarse aggregate for portland cement concrete

2.2 Data Analysis

The intent of the analysis was to determine appropriate intervals to contain allowable differences between the plant test results and the IAST test results. Data retrieved from various queries were transferred to MS Excel and MINITAB for certain statistical analysis. The 90% and 80% intervals on the difference between the individual test results and the IAST results were obtained under the assumption that the data followed a normal distribution. Determination of 90% and 80% intervals can be expressed mathematically as:

$$\{\mu - (Z_{\alpha/2})\sigma \ , \ \mu + (Z_{\alpha/2})\ \sigma\} \qquad (1)$$

where, α = 0.1 for 90% interval and 0.2 for 80% interval respectively, and

μ = mean,

σ = standard deviation.

A normal distribution of test differences showing 80% and 90% prediction intervals is illustrated in Figure 5.

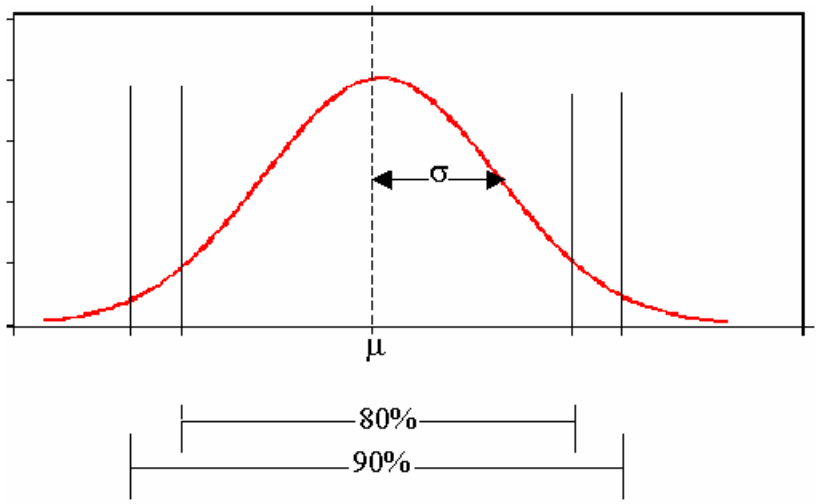

Figure 5 – Normal distribution of test differences with 80% and 90% prediction intervals

The statistical software MINITAB was employed in determining the adequacy of the analytical model and in conducting the hypothesis testing. The plant test results and the IAST

test results were compared. Paired t-tests were conducted to determine if any significant difference existed between the two test results. The null hypothesis (H_o) that no difference existed between the two results was tested against the alternate hypothesis (H_1) that differences did exist. The hypotheses can be expressed as follows:

H_o: $D = 0$
H_1: $D \neq 0$

where D is the difference between the two test results, i.e., D = Plant Test – IAST Test. The t-test was conducted using a P value of 0.05. The conclusion of the hypothesis testing will be:

Reject H_o, there is a difference if $P \leq 0.05$.

Fail to reject H_o, there is no difference if $P > 0.05$.

If there is no significant difference, the suggested 90% or 80% predication limits will be re-centered at 0 (zero), else the limits will be centered at the calculated mean difference.

3. AN EXAMPLE

In this section, the data entry and the analysis conducted for asphalt content of hot-mix asphalt (in file folder \Ridot\AI 1\) are illustrated as an example. The MS Access form (in file \Ridot\AI 1\Ac.mdb) for entering data for asphalt content of hot-mix asphalt is shown in Figure 6. After all the data for the asphalt content were entered in the form, a table is automatically generated by MS Access as shown in Table 1.

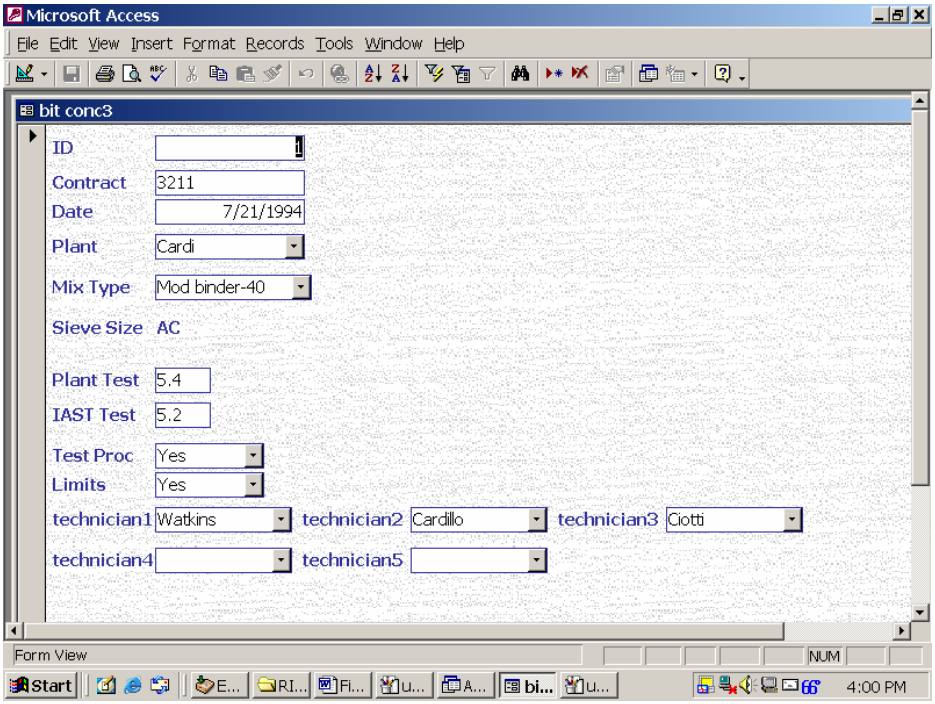

Figure 6 – Data entry form for asphalt content of hot-mix asphalt

Microsoft Access - [bit conc : Table]

File Edit View Insert Format Records Tools Window Help

ID	Contract	Date	Plant	Type of Test	Mix Type	Pt AC	IAST AC	Test P	Limits	Technician 1	Technician 2
1	3211	7/21/94	Cardi	Extraction	Mod binder-40	5.4	5.2	Yes	Yes	Watkins	Cardillo
2	3211	5/11/94	Cardi	Extraction	Classl-1	5.8	5.4*	Yes	No	Watkins	Cardillo
3	3211	9/26/94	Cardi	Extraction	Classl-1	5.7	5.3*	Yes	No	Watkins	Cardillo
4	3211	8/26/94	Cardi	Extraction	1-1/4 mod base	4.5	4.7	Yes	No	Watkins	Cardillo
5	3211	10/18/94	Cardi	Extraction	Mod base-25	5.5	4.9*	Yes	No	Watkins	Ciotti
6	9250	8/31/94	Tilcon	Extraction	1-1/4 mod base	5	5.2	Yes	No	Adamo	Natale
7	9250	5/12/94	Tilcon	Extraction	Mod Base	4.1	4.3	Yes	No	Adamo	DeRobbio
8	9250	9/15/94	Tilcon	Extraction	MOD Binder	5.6	5.3*	Yes	No	Adamo	DeRobbio
9	9250	11/2/94	Tilcon	Extraction	Classl-1	5.7	5.6	Yes	Yes	Adamo	DeRobbio
10	9250	11/2/94	Tilcon	Extraction	Classl-1	5.8	5.5*	Yes	No	Adamo	DeRobbio
11	9250	7/15/94	Tilcon	Extraction	Mod Base	4.8	4.6	Yes	No	Adamo	DeRobbio
12	9250	11/14/94	D'ambra	Extraction	mod base-20	5.2	4.8*	Yes	No	Frigon	Chiaverini
13	9250	11/17/94	Tilcon	Extraction	MOD Binder	4.9	4.9	Yes	No	Adamo	DeRobbio
14	9250	11/17/94	Tilcon	Extraction	1-1/4 mod base	4.3	7.4*	Yes	No	Adamo	DeRobbio
15	9250	7/19/94	Tilcon	Extraction	Mod Base	4.7	4.5	Yes	No	Adamo	DeRobbio
16	9305	6/13/94	J.H.lynch+sons	Extraction	Classl-1	5.6	5.5	Yes	Yes	Grossi	Botelmo
17	9307	6/2/94	D'ambra	Extraction	Mod base-25	5	4.7*	Yes	No	frigon	Ciotti
18	9307	5/20/94	D'ambra	Extraction	Mod base-25	5.4	5.2	Yes	Yes	frigon	Ciotti
19	9309	5/19/94	J.H.lynch+sons	Extraction	Classl-1	6.2	5.5*	Yes	No	Grossi	Ciotti
20	9309	7/23/94	J.H.lynch+sons	Extraction	Mod Base	4.8	5	Yes	No	Kudlacik	
21	9320	9/6/94	D'ambra	Extraction	MOD Binder	4.4	5.1*	Yes	No	Frigon	Chiaverini
22	9323	5/24/94	Tilcon	Extraction	MOD Friction	5.4	4.8*	Yes	No	Adamo	DeRobbio
24	9323	5/9/94	Tilcon	Extraction	MOD Friction	5.3	5*	Yes	No	Adamo	DeRobbio
25	9333	5/11/94	Narragansett	Extraction	Classl-1	6	5.7*	Yes	No	Grossi	Ciotti
26	9334	4/15/94	D'ambra	Extraction	Classl-2	6.3	6.4	Yes	Yes	Ciotti	Chiaverini

Record: 1 of 313

Datasheet View NUM

Start 6:17 PM

Table 1 – Table showing part of 313 data generated for asphalt content of hot-mix asphalt

A query (see Figure 7) was designed to retrieve specific information from the database according to certain required criteria (fields), which in this example is after extraction.

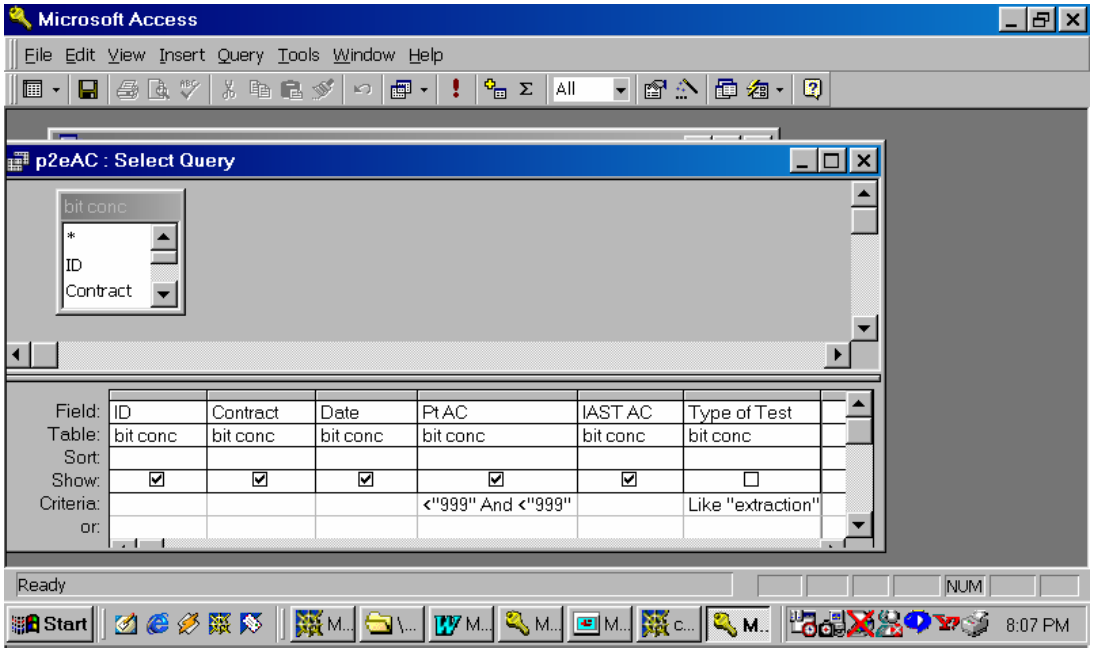

Figure 7 – Query selection for asphalt content after extraction of hot-mix asphalt

When the above query is run, test results of the different plants and IAST for asphalt content of hot-mix asphalt after extraction is generated as shown in Table 2.

ID	Contract	Date	Pt AC	IAST AC
1	3211	7/21/94	5.4	5.2
2	3211	5/11/94	5.8	5.4*
3	3211	9/26/94	5.7	5.3*
4	3211	8/26/94	4.5	4.7
5	3211	10/18/94	5.5	4.9*
6	9250	8/31/94	5	5.2
7	9250	5/12/94	4.1	4.3
8	9250	9/15/94	5.6	5.3*
9	9250	11/2/94	5.7	5.6
10	9250	11/2/94	5.8	5.5*
11	9250	7/15/94	4.8	4.6
12	9250	11/14/94	5.2	4.8*
13	9250	11/17/94	4.9	4.9
14	9250	11/17/94	4.3	7.4*
15	9250	7/19/94	4.7	4.5
16	9305	6/13/94	5.6	5.5
17	9307	6/2/94	5	4.7*

Pt AC – plant test for asphalt content, IAST AC – IAST test for asphalt content

Table 2 – Query results showing part of the 278 data points generated for Asphalt Content

The data retrieved from the query is used in the statistical analysis for the development of variation limits. Table 3 shows a partial Excel spreadsheet (in file \Ridot\AI 1\Ac.xls) of 317 pairs of asphalt content data where 278 of them used the extraction method. For each pair, the difference was calculated and the mean (μ) and standard deviation (σ) of their difference were obtained. Any difference exceeding 2.5 standard deviations from the mean was treated as an outlier[1] and was deleted. In this example, three such points were deleted and 275 data points were used in determining the limits. The limits were recalculated by using the formula:

$$\{\mu - (Z_{\alpha/2})\sigma \ , \ \mu + (Z_{\alpha/2})\sigma\} \qquad (1)$$

This procedure was applied to all sets of data. The column highlighted (darker shade) shows the IAST comparison results. The URI 90% and 80% are the comparison results obtained based on the 90% and 80% intervals developed respectively. The responses to the URI 90% and URI 80% limits are either "yes" or "no" depending upon the conformance or non-conformance of differences between plant and IAST test results to their respective prediction intervals. The URI 90% and 80% limits for the test result of asphalt content for hot-mix asphalt after extraction were calculated using (2) as follows,

URI 90% limits = $(\mu - Z_{0.05}*\sigma \ , \ \mu + Z_{0.05}*\sigma)$

$= (0.0392 - 1.645*0.2728 \ , \ 0.0392 + 1.645*0.2728) = (-0.410 \ , \ 0.488)$

URI 80% limits = $(\mu - Z_{0.1}*\sigma \ , \ \mu + Z_{0.1}*\sigma)$

$= (0.0392 - 1.282*0.2728 \ , \ 0.0392 + 1.282*0.2728) = (-0.311 \ , \ 0.389)$

where, $\mu = 0.0392$, $\sigma = 0.2728$, $Z_{0.05} = 1.645$, $Z_{0.1} = 1.282$

[1] A very common defect occurs on a normal probability plot, usually exhibits a much larger or smaller value than others. Such a data point will be referred to as an outlier.

ID	Contract	Date	Pt AC	IAST AC	Diff	Limits	URI 90%	URI 80%
1	3211	7/21/94	5.4	5.2	0.2	Yes	Yes	Yes
2	3211	5/11/94	5.8	5.4	0.4	No*	Yes	no
3	3211	9/26/94	5.7	5.3	0.4	No*	Yes	no
4	3211	8/26/94	4.5	4.7	-0.2	Yes	Yes	Yes
5	3211	10/18/94	5.5	4.9	0.6	No*	no	no
6	9250	8/31/94	5	5.2	-0.2	Yes	Yes	Yes
7	9250	5/12/94	4.1	4.3	-0.2	Yes	Yes	Yes
8	9250	9/15/94	5.6	5.3	0.3	No*	Yes	Yes
9	9250	11/2/94	5.7	5.6	0.1	Yes	Yes	Yes
10	9250	11/2/94	5.8	5.5	0.3	No*	Yes	Yes
11	9250	7/15/94	4.8	4.6	0.2	Yes	Yes	Yes
12	9250	11/14/94	5.2	4.8	0.4	No*	Yes	no
13	9250	11/17/94	4.9	4.9	0	Yes	Yes	Yes
14	9250	11/17/94	4.3	7.4	-3.1	No*	NO	NO
15	9250	7/19/94	4.7	4.5	0.2	Yes	Yes	Yes
312	9624	6/12/96	5.7	5.9	-0.2	Yes	Yes	Yes
313	9633	10/29/96	5.9	5.8	0.1	Yes	Yes	Yes
314	9633	11/13/96	6	6	0	Yes	Yes	Yes
315	9633	12/16/96	5.8	5.6	0.2	Yes	Yes	Yes
316	9635	11/6/96	5.6	5.9	-0.3	No*	Yes	Yes
317	9637	11/27/96	4.8	4.7	0.1	Yes	Yes	Yes
	Mean	0.0392		N=275				
	Standard Deviation	0.2728						
		90% Prediction interval for mean difference					-0.41	0.49
		80% Prediction interval for mean difference					-0.32	0.39

* Limits – Original IAST limits.

Table 3 – Excel spread sheet for analysis and comparison

A paired t-test was conducted to test the significance of the differences. A histogram on the differences was plotted to observe if any trends could be observed in the data, as shown in Figure 8. Since the p-value in this case, 0.018, is less than 0.05, it can be concluded that a significant difference exists. Hence, the variation limits will be centered at the mean difference of 0.0392 instead of 0 (zero).

Test of mu = 0.0000 vs mu not = 0.0000

Variable	N	Mean	StDev	SE Mean	T	P
Diff	275	0.0392	0.2728	0.0165	2.38	0.018

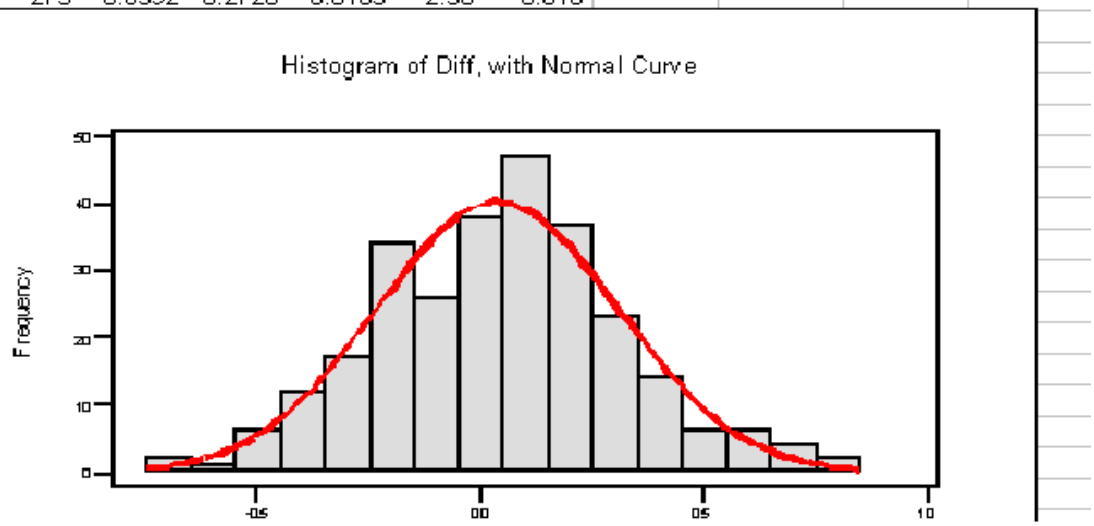

Figure 8 – Paired t – test

Both the 80% and 90% intervals on the difference between the individual test results and the IAST are determined under the assumption that the data followed a normal distribution. Plotting the normal probability plot on the difference of the test results as shown in Figure 9 validates the adequacy of this assumption model.

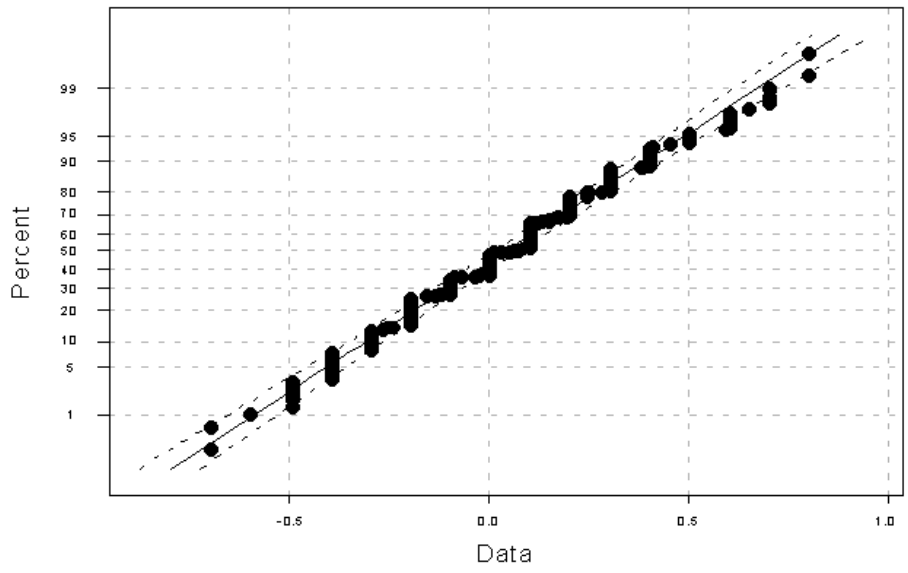

Figure 9 – Normal probability plot for checking model adequacy

From Figure 9, it can be observed that most of the data falls along a straight line, following the normal probability plot. Hence, it can be concluded that the normal distribution assumption is adequate.

Asphalt Content	Suggested IAST limits			
	URI 90%		URI 80%	
	L	U	L	U
Extraction	-0.410	0.488	-0.311	0.389

Table 4 – IAST Limits for Asphalt Content

In conclusion of this illustration, Table 4 gives the suggested 90% and 80% intervals for the asphalt content of hot-mix asphalt after extraction.

4. SUGGESTIONS

The URI 90% and 80% limits were compared with the existing IAST limits. The 80% limits yield test results that are less liberal than the 90% limits. They offer a tighter variation limits and agree better with the current IAST limits, hence, the URI 80% limits are suggested as the new IAST limits. It shall be noted that these variation limits were derived from past data (1991 –1999). In order to determine IAST limits for a new test, the following standard procedure can be followed.

a. Collect adequate results from the plant tests and from the IAST tests.
b. Enter results into a database or a spreadsheet.
c. Calculate the difference, D_i, between each paired plant test and IAST test

   where D_i = the *ith* plant test result – the *ith* IAST test result. Delete any abnormally large or small D_i from the data set.
d. Calculate the mean, μ, and the standard deviation, σ, of all D_i.

e. Conduct a paired t-test with α of 0.05 to determine whether the mean of the differences differ from 0 (zero) or not.

f. If the mean of differences is not 0 (zero), the IAST limits can be obtained as:

$$\text{URI 90\% limits} = (\mu - Z_{0.05}*\sigma , \mu + Z_{0.05}*\sigma),$$

$$\text{URI 80\% limits} = (\mu - Z_{0.1}*\sigma , \mu + Z_{0.1}*\sigma),$$

otherwise, the IAST limits are:

$$\text{URI 90\% limits} = (- Z_{0.05}*\sigma , + Z_{0.05}*\sigma),$$

$$\text{URI 80\% limits} = (- Z_{0.1}*\sigma , + Z_{0.1}*\sigma),$$

where $Z_{0.05} = 1.645$ and $Z_{0.1} = 1.282$

g. Adopt the 80% limits for a tighter inspection, otherwise adopt the 90% limits.

When limits for sieve analyses are chosen, the tolerances for the percent passing each sieve should be examined. Tolerances should be greatest at 50% and diminish as the percent passing approaches 0% and 100%. If this is not the case, the data should be reexamined to determine the cause of the anomaly.

The same procedure described in sections a thru g above were followed when analyzing all test results recorded between 1991 and 1999. Comprehensive tables for different tests and their corresponding variation limits are attached in the appendices. The MS Access database, the MS Excel spreadsheets, and all accompanying statistical analyses as well as this report are packaged on the attached CD.

Appendix I contains variation limits for testing hot mix asphalt

a) Asphalt content after burnoff and extraction ------ see Table AI 1

b) Gradation after burnoff and extraction ---------- see Table AI 2

c) Specific gravity of cores (combined) – by plant ------ see Table AI 3

d) In-place density testing of HMA ---------- see Table AI 4

Appendix II contains variation limits for testing portland cement concrete

a) Slump and air content of concrete ---------- see Table AII 1

b) Gradation of coarse aggregate and fine aggregate ---- see Table AII 2

c) Gradation of fine aggregate ---------- see Table AII 3

d) Concrete Testing (7 days) ---------- see Table AII 4

e) Concrete Testing (28 days) ---------- see Table AII 5

Appendix III contains variation limits for testing soils

In place density and moisture content ---------- see Table AIII 1

APPENDIX I - TEST RESULTS FOR HOT MIX ASPHALT

a) Table AI 1 - Asphalt content after burnoff and extraction (File: /RIDOT/AI 1/ Ac.xls)

	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
Burnoff	35	-0.254	0.490	-0.173	0.410
Extraction	278	-0.410	0.488	-0.311	0.389

b) Table AI 2 - Gradation after burnoff and extraction (File: /RIDOT/AI 2/ p4e.xls)

	Sieve Size	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
Burnoff	1"	14	0.000	0.000	0.000	0.000
	3/4"	35	-2.462	2.462	-1.923	1.923
	1/2"	37	-2.634	2.634	-2.057	2.057
	3/8"	34	-5.600	5.600	-4.374	4.374
	#4	33	-4.794	4.794	-3.745	3.745
	#8	34	-2.803	2.803	-2.190	2.190
	#30	33	-1.344	1.344	-1.050	1.050
	#50	34	-1.206	1.206	-0.942	0.942
	#100	34	-1.137	1.137	-0.888	0.888
	#200	34	-0.932	0.932	-0.728	0.728
Extraction	1"	126	-0.683	0.805	-0.520	0.642
	3/4"	266	-1.608	1.608	-1.256	1.256
	1/2"	242	-3.680	3.680	-2.875	2.875
	3/8"	279	-5.241	5.241	-4.094	4.094
	#4	242	-4.307	4.307	-3.364	3.364
	#8	279	-2.746	3.528	-2.060	2.841
	#30	222	-1.328	1.328	-1.037	1.037
	#50	279	-0.870	1.016	-0.663	0.809
	#100	279	-0.790	0.963	-0.598	0.771
	#200	279	-0.630	0.630	-0.492	0.492

c) Table AI 3 – Bulk Specific gravity of cores – by plant (File: /RIDOT/AI 3/ p6e.xls)

Specific Gravity	Plant	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
Combined	Cardi	140	-0.012	0.008	-0.009	0.006
	D'ambra	124	-0.030	0.018	-0.025	0.013
	Lynch	57	-0.010	0.010	-0.008	0.008
	Narrgansett	24	-0.030	0.014	-0.020	0.009
	Tilcon	256	-0.031	0.010	-0.027	0.006
	Overall*	601	-0.027	0.013	-0.022	0.009
	Base	116	-0.018	0.014	-0.014	0.010
	Binder	108	-0.017	0.006	-0.015	0.003
	Class I-1	300	-0.019	0.007	-0.016	0.005
	Class I-2	16	-0.028	0.028	-0.022	0.022
	Friction	42	-0.011	0.005	-0.009	0.003

* Overall – Combined results of all plants.

d) Table AI 4 - In-place density testing of HMA (File: /RIDOT/AI 4/ f3e.xls)

In-Place Density		Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
Density	Class I-1	436	-1.307	1.693	-0.978	1.365
	Friction	31	-1.326	1.326	-1.036	1.036
	binder	128	-1.210	1.771	-0.884	1.445
	base	207	-1.254	1.537	-0.948	1.232
	others	38	-1.523	1.523	-1.190	1.190
	150	472	-1.212	1.655	-0.898	1.341
	140	319	-1.424	1.693	-1.083	1.351
	0-139	49	-1.500	1.500	-1.172	1.172

APPENDIX II - TEST RESULTS FOR PORTLAND CEMENT CONCRETE

a) Table AII 1 - Slump and air content of concrete (File: /RIDOT/AII 1/ f2e.xls)

		Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
Slump	3/4"Concrete	282	-0.600	0.443	-0.480	0.329
	1/2"Concrete	55	-0.488	0.488	-0.379	0.379
	1-1/2"Concrete	33	-0.479	0.479	-0.372	0.372
	Concrete	21	-0.481	0.481	-0.373	0.373
Air	3/4"Concrete	324	-0.410	0.498	-0.310	0.398
	1/2"Concrete	64	-0.381	0.381	-0.299	0.299
	1-1/2"Concrete	36	-0.360	0.360	-0.280	0.280
	Concrete	29	-0.335	0.335	-0.263	0.263

b) Table AII 2 - Gradation of coarse and fine aggregate (File: /RIDOT/AII 2/ f1e.xls)

Aggregate gradation

Aggregate Type	Sieve Size	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
1/2"	1"	46	0.000	0.000	0.000	0.000
3/4"		36	0.000	0.000	0.000	0.000
1/2"	¾"	26	0.000	0.000	0.000	0.000
3/4"		37	-2.669	2.669	-2.087	2.087
1/2"	½"	25	-3.191	3.191	-2.492	2.492
3/4"		22	-9.690	9.690	-7.570	7.570
1/2"	3/8"	27	-6.243	6.243	-4.877	4.877
3/4"		38	-7.872	3.986	-6.574	2.688
1/2"	#4	27	-1.109	1.109	-0.8675	0.8675
3/4"		38	-2.057	2.057	-1.607	1.607
1/2"	#8	27	-0.992	0.992	-0.773	0.773
3/4"		37	-2.540	1.616	-2.080	1.162
1/2"	#16	21	-0.795	0.795	-0.620	0.620

c) Table AII 3 Fine Aggregate (File: /RIDOT/AII 3/ p3e.xls)

Sieve Size	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
3/8"	227	-0.040	0.045	0.030	0.036
#4	227	-0.780	0.453	-0.650	0.318
#8	227	-2.540	1.309	-2.120	0.888
#16	227	-1.638	1.638	-1.279	1.279
#30	227	-1.663	1.663	-1.296	1.296
#50	227	-1.440	1.070	-1.170	0.790
#100	227	-0.370	0.880	-0.230	0.750
FM	227	-0.040	0.060	-0.030	0.050

d) Table AII 4 – Concrete testing -7 days (File: /RIDOT/AII 4/ 7days.xls)

Concrete Testing

Day-break	Aggregate Size	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
7-Day	3/4"	133	-430.332	430.332	-336.156	336.156
	1/2"	40	-262.049	262.049	-204.701	204.701

e) Table AII 5 - Concrete testing – 28 days (File: /RIDOT/AII 5/ 28days.xls)

Concrete Testing

Day-break	Aggregate Size	Number of Test Results	Suggested IAST limits URI 90% limits		URI 80% limits	
28-Day	3/4"	261	-526.894	526.894	-411.586	411.586
	1/2"	80	-453.691	453.691	-354.403	354.403

APPENDIX III - TEST RESULTS FOR SOILS

Table AIII 1 -Test Results of Soils (File: /RIDOT/AIII 1/ moist.xls)

Soils	Number of Test Results	Suggested IAST limits			
		URI 90% limits		URI 80% limits	
In place density	144	-0.716	0.952	-0.533	0.769
Moisture content	65	-0.711	1.108	-0.512	0.909